

# Continuous-Wave Fiber Laser User Guide

适用机型: RFL-C2000S-HP RFL-C3000S-HP RFL-C4000S-HP RFL-C6000S-HP

Wuhan Raycus Fiber Laser Technologies Co., Ltd

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#### **1** Safety Information

Thank you for choosingRaycus fiber laser. This User Guide provides important safety, operation, warranty and other information. Please read it carefully before you use this product. In order to ensure safe operation and optimal performance of the product, please follow the warnings, cautions, operating procedures and other instructions accordingly.

#### 1.1 Symbols Used in this User Guide



• WARNING: Refers to a potential hazard that may leads to a personal injury or death.



• CAUTION: Refers to potential a hazard that may leads to aminorpersonal injury or product damage.

#### **1.2 Laser Classification**

This series of lasers areclassifiedas a high power Class 4 laser instrument according to the European Community standards EN 60825-1, clause 9. This product emits invisible laser radiation at or around a wavelength of 1080 nm, and the total light power radiated from the optical output is greater than 300W~6000W (depending on model). Direct or indirect exposure of this level of light intensity may cause damage to the eyes or skin. Despite the radiation being invisible, the beam may cause irreversible damage to the retina and/or cornea. Appropriate and approved laser safety eyewear must be worn all the time while the laser is operating.



◆ WARNING: The laser safety eyewearshall be used when this device is operating. Thelaser safety eyewear is selected according to the range of wavelengths emitted from this product. The end user must ensure that the laser safety eyewear being used protects against light emitted by the device over its entire range of wavelengths. Please verify that the personal protective equipment (e.g. enclosures, viewing windows or viewports, eyewear, etc.) being utilized is adequate for the output power and wavelength ranges listed on the product.

#### 1.3 Safety Labels

The safety labels is as shown in Figure 1:

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Laser safety labels include safety warning, laser output head warning, product certification, and product nameplate. The detailed description of the security identifier is as follows:



#### Table 1 Specifications of Safety Labels

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	Model n China	
4: CE Certification	5: Laser Label	6: Laser Radiation Hazard
7:Strong electric Hazard		

#### 1.4 Optical Safety

Any dust on the end of the collimator assembly can burn the lens.



• CAUTION: DO NOT emit laser when the protective cap is not removed, otherwise the lens or crystal will be damaged.

### 1.5 Electrical Safety

a) Make sure the product is firmly grounded through the PE line of the AC power cord



• WARNING: Any interruption from the protective earth will electrify the enclosure, which may result in personal injury for operators.

b) Make sure that the correct voltage of the DC power source is used.



• Wrong wiring mode or power supply voltage will cause an irrecoverable damage to the laser device.

#### 1.6 Other Safety Rules

- a) Do not directly look the laser fiber delivery cable connector when laser emitting.
- b) Do not use fiber lasers in dark environment.
- c) If this device is used in a manner not specified in this document, the protectionprovided by the device may be impaired and the warranty will be voided.
- d) There are no user serviceable parts, equipment or assemblies inside the product. All service and maintenance shall be performed by Raycus. In order to prevent electric shock, please do not break the seal or uncover the shield. Failure to comply with this instruction will void the warranty.

#### **2** Product Description

#### 2.1 Features

Raycus fiber laser, compared with traditional laser, has higher electro-optical conversion efficiency, lower power consumption and more excellent beam quality. It is compact and ready to use. Because of flexible laser output mode, it can be easy to integrate the device.

Main Features:

- Excellent beam quality
- High reliable and sealing
- High power stability
- > Power continuously adjustable and fast switch response
- Maintenance-free operation
- High Electro-optical Conversion Efficiency
- Anti-reflection Capacity
- ▶ High modulation frequency and editable waveform Applications:
- ▶ Welding、5G、Infrastructure
- ➢ 3D printing
- ► Laser research

Applications:

- ▶ Welding、5G、Infrastructure
- ➢ 3D printing
- Laser research

#### 2.2 Package accessories

Please refer to package accessories in the packing box.

#### 2.3 Unpacking and inspections

Raycus fiber laser is delivered with the specially designed package to offer the fiberlaser maximal safety. Nevertheless, in order to prevent the occurrence of unpredictable circumstances during the transportation, please inspect all packaging once receiving the delivery. If you find any evidence of mishandling or damages, please keep the damaged material and contact the shipping agent and Raycus immediately.

Please double check if each listed content is included inside the package; and contactRaycus as soon as possible if there are any issue.

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User Guide RFL-C2000S-HP-RFL-C6000S-HP Take extra care when removing the unit from the package and make sure the fiber optic cable stays away from any possible collision and vibration. Please do NOT distort, bend or pull the output cable when unpacking the device; and avoid any collision to the fiber delivery cable connector.



• CAUTION: The fiber optic cable and fiber delivery cable connector are precise optic instrument, ANY vibration or impact to the fiber delivery cable connector, and twist orexcessive bend to the cable will damage the instrument.

### 2.4 Operation Environment

The operation conditions are listed as the following table:

Table 2 Laser operation environme	ent
-----------------------------------	-----

Madal	RFL-C2000S-	RFL-C3000S	RFL-C4000S-	RFL-C6000S-		
Niddei	HP	-HP	HP	HP		
Power Voltage	360~510V AC 50/60Hz					
(V)		500 5101				
Power Capacity	75	11.5	15	22		
(kVA)	1.5	11.5	15			
Installation	Flat and no vibration					
Environment	Flat and no violation					
Ambient Temperature	10~40					
(°C)	10 40					
RelativeHumidity	20.70					
(%)	30~70					

#### Warning:

- a) Make sure the product is properly grounded before use.
- b) The laser output head is connected with fiber optic cable. Please inspect the output head carefully to prevent dust or other contaminations. Use appropriate lens paper to clean it if necessary.
- c) Failure to follow the instructions when operating the laser may cause malfunction and damage.
- d) It is not allowed to install the output head when the laser is in operation.
- e) Do not look into the output head directly. Wear appropriate protective eye glasses all the time when operating the laser



• Do not expose this product to high humidity (humidity>95%)

• Do not allow this product to operate at a temperature below the ambient dew point. (As shown in Table 3)

Table 3 Comparison table of constant dew point at ambient temperature and relative humidity

Constant dew point table at ambient temperature and relative humidity									
Ambient Maximum relative humidity									
(°C)	20%	30%	40%	50%	60%	70%	80%	90%	95%
20	-3.5	2	6	9	12	14.5	16.5	18	19
25	0.5	6	10.5	14	16.5	19	21	23	24
30	4.6	10.5	15	18.5	21.5	24	26	28	29
35	8.5	15	19.5	23	26	28.5	31	33	34
40	13	20	24	27.5	31	33.5	36	38	39
Laser operating temperature range									

Green areas: dew point temperature lower than laser cooling water temperature
 22 °C, belongs to the scope of security



◆ Red areas: dew point temperature is higher than 22 °C, more than laser cooling water temperature 22 °C, will produce condensation, measures must be taken prior to use.

Measure 1, see Section 4.2. Access clean and dry air from CDA port to reduce relative humidity

Measure 2, Install a cabinet air conditioner to lower the ambient temperature.

#### 2.5 Attentions

- a) Make sure that the correct voltage is used before connecting AC current. Failure to connect power supply will damage the device.
- b) Failure to operate the laser in accordance with the control or adjustment methods specified in this manual may cause damage.
- c) For the output laser collimated by the collimating lens, it is important to keep the collimating lens clean, otherwise it will damage the device.
- d) Please cap the output head when it is not in use. Do not touch the output lens at any time. Use appropriate lens paper and alcohol to clean it if necessary.
- e) Failure to follow the instructions may cause laser power loss, and such loss is not covered by warranty.

### 2.6 Specifications

Table 4 Product Specifications

F		I		-			
Model	RFL-C2000S- HP	RFL-C3000S- HP	RFL-C4000S- HP	RFL-C6000S- HP	Test Conditions		
	Optical Characteristics						
Output Power(W)	$2100 \pm 100$	$3100 \pm 100$	$4100 \pm 100$	$6100 \pm 100$			
Operation Mode		CW/Mo	dulated				
Polarization		Rand	lom				
Power Range(%)		10~	100				
Emission Wavelength		1080	)±5		Nominal Output		
Output Power Instability (%)		±1.5					
Modulation Frequency(Hz)		1~5,000					
Red Guide Laser Power(mW)							
	Output Char	acteristics					
BPP (mm*mrad)		3-4					
NA		0.	2				
Fiber core (µm)		10	0		Customizable		
Output cable length (m)		20	)		Customizable		
	Electrical Cha	aracteristics					
Power Supply		360~510 V A	C、50/60Hz				
Max. Power (kW)	6	9	12	18			
Control Mode		AD/FieldBu	ıs/Ethernet				
	Other Chara	acteristics					
Dimensions(W×H×D) (mm)	44						
Weight(kg)	<65	<70	<75	<85			
Operating Ambient Temperature Range (°C)							
Humidity(%)		30~	70				
Storage Temperature(°C)		-10~	-60				
Cooling Method							

#### **3** Installation

#### 3.1 Dimensions

Figure 2 shows the external dimensions of the RFL-C2000S-HP/RFL-C3000S-HP/ RFL-C4000S-HP/ RFL-C6000S-HP.(take C4000S as an example)



Figure 2 (a) Front view (Unit: mm)



Figure 2 (b) Rear view (unit: mm)

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Figure 2 (c) Side view (Unit: mm)

#### 3.2 Size and installation of output optical cable

ThestandardoutputcablesofRaycusRFL-C2000S-HP/RFL-C3000S-HP/RFL-C4000S-HP/RFL-C6000S-HPfiberlasersareQBHoutput cables.The specific appearance dimensions are shown in Figure 3 below:

Compared with other types of laser output cable, there are differences in the size of the protective end cap of this type is lengthened.



Figure 3 Dimensional drawing of QBH output optical cable (unit: mm)

Before installing the output cable in the processing head, the lens of the output cable must be inspected. If the lens is dirty, it must be cleaned.
 It is forbidden to disassemble the output lens by anyone other than Raycus, otherwise the warranty will be invalid.
 Before the laser is used, it is necessary to ensure that the two copper rings of the output cable are fitted with the cutting head to form a short connection state.

#### 3.3 Cooling system installation and requirements

Table 5 Cooling system requirements

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Model	RFL-C2000S         RFL-C3000S-           -HP         HP		RFL-C4000S- HP	RFL-C6000S -HP		
Cooling capacity W	>5000 >7500		>10000	>15000		
Minimum flow rate L/min	3	36	40	52		
Max. input pressure Bar	7					
Water pipe size inner diameter mm	25					
Cooling system water temperature $(\ \C\ )$	$22 \pm 1$					

- a) Cooling system water temperature setting:  $22 \pm 1^{\circ}$
- b) Coolant requirements:
  - 1) The cooling water is pure water and it is recommended that pure drinking water can be used.
  - 2) To prevent the growth of mould in the water in the chiller leading to blocked pipes, it is recommended to add ethanol at a volume ratio of 10% when refilling with pure water.
  - 3) When the ambient temperature around the equipment is between  $-10^{\circ}$  C and  $0^{\circ}$  C, an ethanol solution with a volume ratio of 30% must be used and changed every two months.
  - 4) When the ambient temperature around the equipment is below  $-10^{\circ}$  C, a dual system (with heating function at the same time) chiller must be used and the cooling system must be guaranteed to run uninterrupted.
- c) Output fiber optic cable water cooling requirements:
  - 1) Water cooling flow: 1.7-2.0L/min.
  - 2) Water cooling pressure: Water inlet less than 0.6Mpa.
  - 3) Type of inlet and outlet fittings: SMC MS-5H-6.
  - 4) Type of water pipe: Outer diameter 6, inner diameter 4.
  - 5) Cooling water direction: unidirectional, connected to the water pipe in strict accordance with the inlet and outlet directions marked on the housing.
  - 6) Cooling water quality: deionized water, distilled water, pure water.
  - 7) Cooling water PH value: 5.5-9.

- The water cooler needs to be equipped with a filter cartridge with a particle size of less than 100um.
- 9) Maximum cooling water temperature: 45° C.
- 10) Minimum cooling water temperature: greater than 5° C above the saturation dew point temperature.
- 11) Additives in cooling water: meet the above PH and solid particle size requirements.
- 12) Bending radius of the armoured tube: In non-working conditions such as transport and storage, the minimum bending diameter shall not be less than 30cm. In the laser outgoing condition, the minimum bending diameter shall not be less than 40cm.
- 13) Long-term vibration, less than 2G; shock, less than 10G.
- d) Other requirements for cooling systems:
  - When first starting up the cooling system, the entire water system and joints should be checked for leaks. The external water pipes must be installed and connected according to the water inlet (IN) and water outlet (OUT) marked on the laser, otherwise the laser may not work properly.
  - 2) The laser should be emptied of cooling water inside the cooling system and inside the laser if it is not used for a long time, otherwise it will cause irrecoverable damage to the laser.



Please set the water temperature of the cooling system correctly. A high water temperature setting will result in the laser not working properly and a low water temperature setting will result in condensation inside the laser or on the laser output cable, which will cause irreversible damage to the laser.
Please clean the water inlet filter assembly promptly. A blockage in the water inlet filter assembly will trigger a laser flow alarm or high temperature alarm.



• Before switching on the laser, it must be ensured that the cooling system is working properly and that the water temperature is at a suitable temperature.

[Water temperature setting:  $22 \pm 1^{\circ}$ C]

#### **3.4 Installation considerations**

- a) Place the laser horizontally in a suitable position and make the necessary fixings.
- b) Before powering up the laser, please check that the laser power supply voltage is stable (see Table 4 for laser models and corresponding power supply voltages) and that the grounding wire is good.
- c) Connect all the power cables of the laser as well as the control cables in an unpowered state.
- d) Connect the cooling system to the laser and the output fiber optic cable according to the inlet and outlet water markings.
- e) Please check the laser output head and clean it as necessary before installing it into the unit. If you find any dust or foreign objects on the laser output head that cannot be cleaned, please contact RESET in good time and do not proceed with the installation or operation of the laser for the time being.
- f) Do not step on, squeeze or excessively bend the yellow/metallic armoured protective sleeve during installation of the output cable to avoid damage to the fiber.
- g) During installation and disassembly, please take care to handle the laser output cable gently and do not subject it to vibration.
- h) During the installation of the laser output cable and output head, ensure that the surrounding environment is clean, otherwise the output head may be contaminated (do not use fans to avoid raising dust).
- The minimum bending diameter of the laser output cable should not be less than 30cm in the non-working state such as transportation and storage, and 40cm in the outgoing state.



 $\blacklozenge$  All control cable connections to the laser should be made in a non-energised state; installing control cables with electricity may cause damage to the laser.



• The laser output cable must be placed in as natural a state as possible and it is forbidden to twist the output cable.

• Too small a coiled diameter of the output fiber optic cable can lead to damage to the laser.



 $\blacklozenge$  The lens and cutting head cavity must be clean and free of contamination before the laser output optical cable is assembled.

• Keep the protective cap on the output head in a safe place to prevent it from being contaminated; otherwise indirect contamination of the output head will occur when the cap is closed.

#### 4 Guiding

# Please use the new version of the Raycus software and the instruction manual for the Raycus software.

#### 4.1 Front panel

Figure 4 shows the front panel style of the RFL-C2000S-HP/RFL-C3000S-HP/RFL-C4000S-HP/RFL-C6000S-HP laser (take C6000S as an example):



Figure 4 Front Panel of RFL-C6000S-HP fiber laser

(1) LASER: Emission indicator, laser out light Laser red light on.

(2) **POWER:** Control power indicator, white light indicates that the control system is on.

3 ALARM: Alarm indication, when the yellow light is on it means that an alarm has occurred on the machine.

#### 4.2 Rear Panel

Figure 5 Rear Panel of RFL-C2000S-HP/ RFL-C3000S-HP/ RFL-C4000S-HP/ RFL-C6000S-HP Fiber laser (take C6000S as an example) :



#### Figure 5 Rear Panel of RFL-C6000S-HP Fiber laser

(1) **WATER**: The water pipe interface, inlet and outlet are connected to the inflow and outflow of cooling water respectively, please connect this interface to the PU pipe of the corresponding outer diameter size according to the laser model (see Table 5 for laser model and corresponding water pipe size).

(2) CDA: Clean and dry air connection for access to clean and dry air to prevent condensation on the laser.

(3) AC INPUT: The power input socket must be connected to the corresponding input voltage according to the laser model (see Table 4 for laser model and corresponding input voltage), and the matching plug provided by Roca must be used.

(4) **POWER:** Air switch to control the on/off of AC power.

**(5) FIELDBUS:** Bus interface (reserved).

(6) ETHERNET: Ethernet interface. Provides remote control of the laser and storage of alarm information.

(7) **CTRL-INTERFACE:**Control interface, CTRL-INTERFACE interface (24-pin), multi-functional multiplex port, which allows the user to set the control mode, input the analogue voltage signal, modulate the 24 V signal and is also the alarm signal output interface.

How to use the CDA:

- a) When using a CDA, the CDA should be dried and cooled by a chiller and filtered by a 5um and 0.3um particle filter and a 0.1um oil mist filter, respectively, at a temperature in the range of 5-40°C, with a maximum dew point of 0°C (it is recommended that the compressed air temperature be 5°C below the cooling water temperature), an air pressure of less than 0.1 MPa, a flow rate setting of 10 LPM and a connection pipe diameter of 6 mm.
- b) When using CDA filter components supplied by Roca, the incoming compressed air is to be dried and cooled by a chiller with an air pressure of less than 0.8 MPa and a connection tube diameter of 6 mm.
- c) Ventilation must be started 30 minutes before the start of the machine, but in winter, when the temperature is below 10°C and the humidity is below 50%, ventilation may not be used.

#### 4.3 Power connections



• Before connecting AC power, verify that the laser model and the supplied AC power supply are the same as those listed in Table 2 or Table 4.

Model	RFL-C2000S-HP	RFL-C3000S-HP	RFL-C4000S-HP	RFL-C6000S-HP		
Power Supply		360~510V	AC50/60Hz			
Power Cable						
End of Cable	Four strands	of wire, diameter 4 r	nm2, Labelled L1, L	2, L3 and PE		
Descriptions	L1, L2, L3->Phase line PE->Protective earth wire					
Remarks	The plug at the end of the power cord is inserted into the socket marked "AC INPUT" on the rear panel. Note that this plug has an anti-reversal function and that it is locked with the latch after insertion.					

 Table 6
 Power connection requirements

#### 4.4 Control interface definition and connection

#### 4.4.1 Control interface definition

Control is carried out using the CTRL-INTERFACE interface (24-pin), which is defined as follows:



#### Figure 6 CTRL-INTERFACE Schematic

#### Table 7 Definition of the 24-pin interface for laser control

Pin	Signal Name	Signal Type	Signal Level	Signal Drive	Typical Response Time	Description
1	Interlock Ch1A					According to
2	Interlock Ch2A	Contact				"EN954-1" or "ISO13849-1
3	Interlock Ch2B	Closure	24Vdc	0.1A	<500ms	Cat.3PLd". Passive
4	Interlock Ch1B	Input				contact, not to be connected to external voltage or earth.
5	RS232Tx					Transmit Data
6	RS232Rx				120ms	Receive Data
7	RS232Com	Return				RS-232 Return
8	Remote Key	Contact		>1A (Contact		Starts the internal main control board power supply. Passive
9	9 Switch	Closure Input	24 V dc	s and cables)	20s	contact, not to be connected to external voltage or earth.
10	Remote Start	Contact	24Vdc	10m A	16	Start the internal main power supply. Passive contact, no external
11	Button	Input	24740	TOMA	13	voltage or earth connection.
12	Analog Input to control	Analog Input	1-10 Vdc	1 mA	100µs	Current setting analog inputs. 1-10VDC = 10-100% current.
13	Analog Output Power Monitor	Analog output	0-8.0 Vdc	11mA	20µs	Analog output 0-8VDC=0-Pnom
14	Isolated Analog Com	Return				Return for signals on pins 12, 13
15	Modulation+	Digital	5-	6 mA	20µs	5-24VDC Input

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		Input	24Vdc			
16	Modulation-	Return				Return for signal on pin 15
17	Guide Control	Digital Input	5- 24 Vdc	6 mA	120ms	Positive edge turns On red guide laser in Guidelaser external control mode
18	Emission Enable	Digital Input	5- 24Vdc	6 mA	120ms	Positive edge activates emission in external enable mode
19	Laser Error	Digital Output	24Vdc	100mA	120ms	High indicates a laser error status
20	System Common	Return				Return for signals on pins 17-19, 21-24
21	Error reset	Digital Input	5-24V dc	6 mA	120ms	Positive edge resets all resettable errors
22	Laser ready	Digital Output	24Vdc	100mA	120ms	High indicates laser is ready
23	Main poweron	Digital Output	24Vdc	100mA	120ms	High indicatesMain powered on
24	Emission ON	Digital Output	24Vdc	100mA	100us	High indicateslaser is emitting



• Please check the level of the control signal to ensure that it meets the requirements. The laser may be damaged if the voltage exceeds or fluctuates.

The Interlock interface is 24 pin, pin 1 and 4, 2 and 3. If these two pins are disconnected, the laser will interrupt the output of light immediately, the laser Ready signal output will become low, and the laser will display Interlock abnormality.

When one of the Interlock channels is open circuited, it is impossible to start the main laser power supply until the other Interlock channel is also open circuited, and then close both channels before starting the main laser power supply.

For safety, pins 10 and 11 of the control interface cannot be shorted at the same time or in advance with pins 8 and 9, the control system inside the laser starts to detect the rising edge of pins 10 and 11 and executes the power on command of the main power supply after the power on operation self-test is completed.

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• The Interlock interface shall not be connected to the active signal, otherwise the interface will be damaged and the laser will alarm;

◆ After all interlocks are closed, short circuit CTRL INTERFACEpin10 and 11for more than 0.5s, and power on the main power supply; If any Interlock is disconnected, the main power supply will be turned off immediately;

◆ After the main power supply is disconnected, wait at least 10s before re shorting CTRL INTERFACEpin 10 and 11.

#### 4.4.2 Ethernet TCP/IP interface settings

Pin	Function	Description	
1	TX+	Data transmission+	
2	TX-	Data transmission-	
3	RX+	Data reception+	
4	N/C	Noconnection	
5	N/C	Noconnection	
6	RX-	Data reception-	
7	N/C	Noconnection	
8	N/C	Noconnection	

Table 8 Definition of Ethernet interface pins

If conditions permit, please give priority to this interface to obtain better communication stability. The laser and computer must be in the same LAN.

#### Table9 LaserIP address

LaserdefaultIPaddress			
IP address	192.168.0.10		
Subnetmask	255.255.255.0		

IPconfiguration:

- a) Open "Local Area Connection" on your PC, and then click "Properties";
- b) Select "Internet Protocol Version 4" (TCP/IP 4);
- c) Click "Properties" button;
- d) Select "Use the following IP address:" to manually assign IP addresses;
- Assign an IP address of 192.168.0. x (x cannot be 10, because 192.168.0.10 has been assigned to the laser), and then assign a subnetmask address, which is 255.255.255.0 by default;
- f) Click "OK" to confirm the settings and exit. See Figure 7 for details.

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5/00 M		
Connection (	Local Area Connection Properties	
IPv4 Connectivity:	Networking	
Meda State:	nemourg	
Duration:	Connect using:	
Speed:	Intel(R) 82578DM Gigabit Network Connection	Internet Protocol Version 4 (TCP/IPv4) Properties
Details	Configure _	General
	This connection uses the following tems	The second second second second second
Activity Sent — Bytes: 618,139	Clert for Moreoft Networks Clort for Moreoft Networks Clore for Moreoft Networks Clerk Scheduler (Control of Control of	Copy and P address automatically your network administrator for the appropriate P settings.     Copy an IP address automatically     Use the following IP address:     P address:     192 - 168 - 0 - 12
Sincertes SiDeable	Instal University People See	Subnet mark: 255 - 255 - 0 Default gateway: .
41	Description Transmission Control Protocol/Internet Protocol. The defuit wide area network protocol that provides communication across diverse interconnected networks. OK Cancel	Cotan DAS server address automatically Use the following DNS server addresses: Preferred DNS server 64 Nemate DNS server 64 Validate settings upon exit Advanced

Figure 7 IP Settings on PC Side

After the IP setting is completed, open the Raycus software, and the connection status in the corresponding text box on the Raycus softwaremenu shows: connected, indicating that the micro-controller program runs normally and the communication connection is normal. The display menu is shown inbelow Figure 8.

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Wuhan Ra	ycus Fiber Laser <b>//4100</b>	🔋 Se	lect laser	🎖 Mode 🕻	Languag	e 🥝Licer	ise 🎴 About 💳 M	inimize 😫 Exi
<b>1</b> % Power[%]	0.06 kV	v	0 Tempe	°C	Powe	r Rea	ady Alarm	Emission
Control Alarm								
State Emergency	S REM I	node		Control	lain power	OOF	F Rese	et
Laser enable	Temperature	18.995	[°C]	Guide laser		-		
Fiber interlock	Humidity	25.182	[%]	Guide la	aser C	OFF	External control	ONO
Interlock logic	Dew	-1.354	[°C]	Laser			I	
Interlock1	Analog voltage	0.075	[V]	Rise time	[ms]	Fall	time[ms]	Read Set
Interlock2	Frequency	0.000	[Hz]	Program	No		· OFF	Read Set
Ramp control	Duty	0.000	[96]	External E	nable G		External Emission	ONO
Program mode	Pulse width	0.000	[ms]	CAternal C	nable C		External Emission	
Program execut	Fiber water flow	0.000	[L/min]	Analog Co	ontrol (		QCW Mode	OFF
Program complete	Laser water flow	0.000	[L/min]	Power(%)	0	12		
Program exception	Fiber temperature	0	[°C]	O Power[W	0	00	14	4000W
Laser use time		14		Frequency	Duty	PulseWid	th	
Today power on time 00:11:40	Total power on tir	ne 01:	24:03	100	100.00	10.00		
Today laser on time 00:00:03	Total laser on tir	ne 00:	27:54	Read		1		
Laser IP: 192.168.0.10	State: 0	onneo	ted	I I	Moni	tor	Version:	V1.21

Figure 8 Main menu of normal communication connection

#### 4.4.3 RS232 and INTERNET communication command

#### 4.4.3.1 Port configuration

RS-232 configuration as below:

Baud rate: 9600, data bit: 8, stop bit: 1, no parity bit and no flowcontrol.

Ethernet port configuration as below:

Laser default IP address: 192.168.0.10

Laser TCP port: 10001

Laser UDP port: 8099

#### 4.4.3.2 Laser communication protocol (network port & serial port)

All commands and return values in this protocol are composed of ASCII characters. The following points should be noted when entering:

- a) The command is generally composed of 3 or 4 letters, sometimes with additional values.
- b) All commands and return values end with a carriage return character (CR, 0x0D, \r). If

the product receives a string with a "carriage return" character, but the command is invalid, it will return "BCMD\r".

- c) For easy identification, all commands are uppercase letters, but in fact, this product does not distinguish between uppercase and lowercase letters. To facilitate identification, a space is added between the command and the parameter.
- d) The product will send a return value for each command received. The return value generally contains the command content itself. If the returned content contains numeric values or error types, ":" will be used to separate the returned command content from numeric values or error types.

Please see table 10 for specific agreement contents and command examples.

Command	Description	Command Example
ABF	Aiming Beam OFF –Turn off red beam	Send: "ABF\r" Return: "ABF\r"
ABN	Aiming Beam ON – Turn on red beam	Send: "ABN\r" Return: "ABN\r"
DEABC	Disable External Aiming Beam Control –Turn off the external red beam control	Send: "DEABC\r" Return: "DEABC\r"
EEABC	Enable External Aiming Beam Control – Switch to external red beam control	Send: "EEABC\r" Return: "EEABC\r"
DEC	Disable External Control – Turn off AD control mode	Send: "DEC\r" Return: "DEC\r"
EEC	Enable External Control – Switch to AD control mode	Send: "EEC\r" Return: "EEC\r"
DLE	Disable Hardware Emission Control –Forbid to enable the laser from the control interface	Send: "DLE\r" Return: "DLE\r"
ELE	Enable Hardware Emission Control – Allow to enable the laser from the control interface	Send: "ELE\r" Return: "ELE\r"
DGM	Disable Gate Mode – Turn off external modulation mode	Send: "DGM" Return: "DGM"
EGM	Enable Gate Mode – Turn on external modulation mode	Send: "EGM" Return: "EGM"
EMOFF	Stop Emission –Turn off the laser (or disable it )	Send: "EMOFF\r" Return: "EMOFF\r"

Table 10 Specific Agreement Contents and Command Examples of Laser

RFI.	C2000S_HP	/REL_C	3000S-HP	/RFI _	C4000S_HP	REI -	C6000S-H	р
KI L	-020003-111	/ML-C.	50005-111	$/\mathbf{N}^{T}\mathbf{L}^{-}$	-C40003-111/	KI'L-	-000003-11	Ľ

EMON	Start Emission	Send: "EMON\r"
	- Turn on the laser (or enable it) Main Power OFF	Send: "MPWROFF\r"
MPWROFF	– Turn off the main power	Return: "MPWROFF\r"
MPWRON	Main Power ON	Send: "MPWRON\r"
	– Turn on the main power	Return: "MPWRON\r"
SPW	Set Pulse Width	Send: "SPW 100\r" Return: "SPW: 100\r" (Setpulsewidth100ms) Other return value: "ERR: input Err\r" (input pulse width<0.0001) "ERR: Out of Range\r" (Exceeds the maximum pulse width range) "ERR: Duty Cycle too High\r"(The set of duty cycle too high) "ERR: Duty Cycle too Low\r" (Set pulse width <0.02) "SPW: 100,Duty=100%\r"
SPRR	Set Pulse Repetition Rate	Send: "SPRR 1000\r" Return: "SPRR: 1000\r" Other return value: "ERR: input Err\r" (Input frequency <0) "ERR: Out of Range\r" (Exceeds the maximum pulse width range) "ERR: Duty Cycle too High\r"(The set of duty cycle too high) "ERR: Duty Cycle too Low\r" (Set pulse width <0.02) "SPW: 100,Duty=100%\r"
SDC	Set Diode Current – Set the operating current of the optical module (unit:%).The setting value must be lower than 100% and higher than the minimum current setting value, which can be set to 0. If the set value is bigger than 100, the default is input 100.	Send: "SDC 100\r" Return: "SDC: 100\r" Otherreturn value: "ERR: Input Err\r" (input value <0) "Laser is worked in AD Mode\r" (Working in external AD mode, the command is invalid)
RCS	Read Current Setpoint	Send: "RCS\r" Return: "RCS: 56.7\r" (Present current setting value is 56.7%)

RPRR	Read Pulse Repetition Rate	Send: "RPRR\r" Return: "RPRR: 10\r" (Pulse Repetition Rate 10Hz)
RBT	Read Board Temperature	Send: "RBT\r" Return: "RBT: 36.6\r"
RPW	Read Pulse Width	Send: "RPW\r" Return: "RPW: 5.5\r" (Pulse Width is 5.5ms)
RCT	Read Laser Temperature	Send: "RCT\r" Return: "RCT: 34.5\r"
ROP	Read Output Power – Reads the output power in watts.	Send: "ROP\r" Return: "ROP: 4000.4\r"
RSN	Read Serial Number – Reads the serial number of the device.	Sent: "RSN" Return: "RSN:221200251\r"
PERR	Reset Errors –Clear internal errors	Send: "PERR\r" Return: "PERR\r"
RIP	Read IP – Read the current IP address	Send: "RIP\r" Return: "RIP: 192.168.0.10\r"
RMASK	Read Sub-net Mask – Read the current sub-net mask address	Send: "RMASK\r" Return: "RMASK: 255.255.255.0\r"
SIP	Set IP – Set LaserIP	Send: "SIP 192.168.0.10\r" Return: "SIP: 192.168.0.10\r"
SMASK	Set Sub-net Mask – To set the sub-net mask, append a string of decimal digits with "."	Send: "SMASK 255.255.255.0\r" Return: "SMASK: 255.255.255.0\r"
SIP	Set IP – To set the IP address, you need to attach a string of decimal digits with "."	Send: "SIP 10.0.0.231\r" Return: "SIP: 10.0.0.231\r"
SUT	Set Up Time – Set power rise time (unit: ms)	Send: "SUT 50\r" Return: "SUT: 50\r"
SDT	Set Down Time – Set power drop time (unit: ms)	Send: "SDT 50\r" Return: "SDT: 50\r"
RUT	Read Up Time – Read power rise time (unit: ms)	Send: "RUT \r" Return: "RUT: 50\r"
RDT	Read Down Time – Read power drop time (unit: ms)	Send: "RDT \r" Return: "RDT: 50\r"
PSRT	Program Start	Send: "PSRT 1\r" Return: "PSRT: 1\r
PSTP	Program Stop	Send: "PSTP\r" Return: "PSTP\r

Other	Commande	error	Send: "BGM\r" Return: "BCMD\r"
	Read devic – Read the value is 321 meanings o (undefined ignored):	e status product status. The return Bit digital information. The of each bit are as follows or "reserved" bits can be	
	D:4.0	0-Normal operation	
	БПО	1-Authorization time	
	D:+ 1	0-Normal	
	BILI	1-Overheat	
	D'4 2	0-Laser not enabled	
	Bit 2	1-Laser enabled	
		0-Back Reflection OK	
	Bit 3	1-High Back Reflection Level	
	D:4 4	0-External AD mode=off	
	BIL 4	1-External AD mode=ON	
	Bit 5	Reserved	
		Reserved	
STA	Bit 6	0-Normal	Send: "STA"
		1-Slave communication abnormal	The return value 4100 (decimal) can
	Bit 7	Reserved	(hexadecimal) and then converted
	Bit /	Reserved	to binary. It can be seen that Bits2
	Bit 8	0-Aiming Beam OFF	and 12 have been set. That
		1-Aiming Beam ON	means"Laser Enable" is turned on
	D:4 0	0-Laser not ready	and "Modulation" mode is enabled
	BIL 9	1-Laser ready	
	D:+ 10	0-QCW mode=off	
	BILIO	1-QCW mode=on	
	D'4 11	0-main power supply=OFF	
	BIUI	1-main power supply=ON	
	D'4 12	0-Modulation Disabled	
	Bit 12	1-Modulation Enabled	
	D'4 12	Reserved	
	BIT 13	Reserved	
	D:4 14	Reserved	
	B11 14	Reserved	
	Bit 15	0-Laser does not emit beam	

		1-The laser is emitting beam
	D:+ 16	0-Gate Mode Disabled
	ын 10	1-Gate Mode Enabled
	D:4 17	Reserved
	DIL I /	Reserved
	Dit 19	0-External enable mode=off
	DIT 10	1-External enable mode=on
	Dit 10	0-Normal
	DII 19	1-Laser is Error
		0-Slow rise and slow drop mode off
	Bit 20	1-Slow rise and slow drop
		0-The laser operates in "ON"
	Bit 21	1-The laser operates in
		0-Programming mode off
	Bit 22	1-Programming mode on
	D': 22	Reserved
	Bit 23	Reserved
	Bit 24	0-Normal
DI		1-Low temperature fault
	Bit 25	0-Normal
		1-Humidity alarm
	Bit 26	0-Normal
		1-Flow alarm of water flow
	D:+ 27	0-Aimingbeam internal
	DIL 2/	1-Aimingbeamexternal
	Bit 28	0-Normal
	DII 20	1-Flow alarm of water flow
	Bit 29	0-Normal
		1-Critical Error
	D:4 20	0-Optical Interlock OK
	ВП 30	1-Optical Interlock active
	Rit 31	0-Normal
		1-Average power is too high

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```

#### 4.5 Laser installation sequence

- a) Take out the lasercarefully and move it to the installation position;
- b) Remove the protective cap of the outputcable head, and use strong light to check whether the lens at the output end has dust. If yes, please clean it before installation, and then cover the protective cap of the output head;
- c) Install the output cable on the processing equipment according to the actual situation (install the cooling water pipe of the output headat the same time), pay attention to sorting out the output optical cable, and protect the output head. Remove the protective cap, confirm whether the lens at the output end is clean again, and then install the output head;
- d) Connect the cooling system, water inlet filter assembly and laser cooling water pipe;
- e) Connect the control circuit and power supply according to the control mode.

#### 4.6 Steps of Starting

- a) Make sure the air switch is OFF,all electrical connections must be finished before the laser is powered on;
- b) Short the 1/4, 2/3 pins of CTRL-INTERFACE;
- c) Turn on the chiller and check leakage. If there is no water leakage, turn off the chiller and wait for the laser to turn on;
- d) Turn on the air switch on the rear panel;
- e) Turn on the chiller;
- f) Short the 8/9 pins of CTRL-INTERFACE and start the laser.

#### 4.7 Functions of Raycus software

The RFL-C2000S-HP/ RFL-C3000S-HP/ RFL-C4000S-HP/ RFL-C6000S-HP Raycus software communicates with the main control board through UDP when it is working. Through the background program running in the software and the human-computer interaction operation, the laser parameters are read and set and the control functions are realized. The menu displayed by the software is divided according to functional categories, including control, alarm, about, language selection, authorization, working mode selection and other pages.

#### 4.7.1 The control menu

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Wuhan Ra	aycus Fiber Laser 👰 Select laser	r 🌺 Mode 🛅 Language 🧭 License 👕 About 💳 Minimize 😫 Exi
<b>1</b> % Power[%]	0.06 kW 0 Power[kW] Tempe	°C     Power     Ready     Alarm     Emission
Control Alarm		
State Emergency	REM mode	Control Main power OFF Reset
Laser enable	Temperature 18.995 [°C] Humidity 25.182 [%]	Guide laser Guide laser OFF External control ON
<ul> <li>Interlock logic</li> <li>Interlock1</li> </ul>	Dew -1.354 [°C] Analog voltage 0.075 [V]	Laser       Rise time[ms]     Fall time[ms]     Read     Set
<ul> <li>Interlock2</li> <li>Ramp control</li> </ul>	Frequency 0.000 [Hz] Duty 0.000 [%]	Program No V OFF Read Set
<ul> <li>Program mode</li> <li>Program execut</li> </ul>	Pulse width 0.000 [ms] Fiber water flow 0.000 [L/min]	Analog Control         ON         QCW Mode         OFF
<ul> <li>Program complete</li> <li>Program exception</li> </ul>	Laser water flow0.000[L/min]Fiber temperature0[°C]	○ Power[%]         0           ○ Power[W]         0           ○ @         ⊕
Laser use time Today power on time 00:11:40 Today laser on time 00:00:03	Total power on time       01:24:03         Total laser on time       00:27:54	Frequency     Duty     PulseWidth       100     100.00     10.00       Read     Image: Constraint of the second s
Laser IP: 192.168.0.10	State: Connected	Monitor Version: V1.21

Figure 9 Raycus software control menu

Power [%]	display of the currently set power percentage		
Power[kW]	display of the current average output power of the laser in kW		
Temperature	display of the current water-cooled plate temperature of the laser, in		
remperature	degrees Celsius		
	Indicates the current status of the main power supply		
Power indicator	Green - main power is on		
	Gray - main power is off		
	Indicates the Ready status of the current laser		
Ready indicator	Green - the laser is ready to emit laser beam		
	Gray - the laser not ready		
	Indicates the current alarm state of the laser		
Alarm indicator	Yellow - the laser is abnormal		
	Gray - the laser is not abnormal		
	Indicates the current output state of the laser		
Emission indicator	Red - the laser is outputting laser beam		
	Gray - the laser is not outputting laser beam		

	Pad indicates that the amergency stop button on the front panel of the loser is
	need - indicates that the emergency stop button on the nont panel of the faser is
г	
Emergency	Gray - Indicates that the emergency stop button on the front panel of the laser has
	been reset
	C3000S-C4000S-C6000S HP don't have this function
	Green - the laser works in REM mode
REM	Gray - the laser works in ON mode
	C3000S-C4000S-C6000S HP don't have this function
Lagar Enghla	Green - the laser is enabled
Laser Enable	Gray - the laser not enabled
Fiber Interlook	Green - The Interlock on output cable head is connected
Fiber Interioek	Gray - The Interlock on the output cable head is disconnected
Interlock1	Green - pins 1 and 4 on the control interface are connected
Interioeki	Gray - pins 1 and 4 on the control interface are disconnected
Interlock?	Green - pins 2 and 3 on the control interface are connected
Interioek2	Gray - pins 2 and 3 on the control interface are disconnected
Interlock Logic	Green - Interlock1& 2 meet logic requirements
Interioek Logie	Gray - Interlock1& 2 do not meet logical requirements
Program Mode	Green - The laser is running in programming mode
i iograni wode	Gray - The laser is not running in programming mode
Pamp Control	Green - the laser is running in power ramp-up and ramp-down mode
Kamp Control	Gray - the laser is not running in power ramp-down mode
Programexecut	Program is executing
Programcomplete	Program execution complete
Programexception	Abnormal program execution

Table 12 Description of laser working status display

Moin Dowon	Click ON, the main power is power on					
Main Power	Click OFF, the main power is power off					
Cuida Lagar	Click ON, turn on the red guide beam					
Guide Laser	Click OFF, turn off the red guide beam					
	Click ON, turn on the 17-pin red guide beam control function					
Guide Laser External Control	Click OFF, turn off the 17-pin red guide beam control function					
Guide Laser External Control External Enable Analog Control	Mode power off automatic memory					
	Click ON, turn on the 18-pin enable function					
External Enable	Click OFF, turn off the 18-pin enable function					
	Mode power off automatic memory					
	Click ON, turn on the AD analog mode					
Analog Control	Click OFF, turn off the AD analog mode					
External Enable Analog Control External Emission	Mode power off automatic memory					
External Emission	Click ON, turn on the 15-pin laser control function					
External Emission	Click OFF, turn off the 15-pin laser control function					
Reset	Clear the alarm of the current laser					
Emission ON	Emit laser					
Emission OFF	No emit laser					

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#### 4.7.2 Logmenu

Display all alarm and fault information of the current laser on the log

#### menu.

VRa	Wuhan Ray	ycus Fiber Laser <b>/14100</b>	Select laser 🌋 Mode 🖪	Language 🧭 Lice	nse 🎱 About <del>-</del> Mi	nimize 😒 Exit
	<b>1</b> % Power[%]	0.07 kW	0 ℃ Temperature[°C]	Power Re	ady Alarm	Emission
Contro	I Log Alarm Master	module ACDC mo	dule DCDC module			
No 1	Time 2022-11-08 10:14:50	Type E014	Infomation T2 Open.			
		Read		Clear		
Laser I	P: 192.168.0.10	State: Co	nnected	Diagnostics	Version:	V1.21

Figure 10 Raycus software log menu

#### 4.7.3 "About" Menu

The laser time, model, serial number, main control serial number, key version number and system information are displayed in the about menu, and the Raycus software reads it once from the main control module when the "About" menu is opened.

RFL-C2000S-HP /RFL-C3000S-HP /RFL-C4000S-HP/RFL-C6000S-HP

	About
	aycus
Laser date:	2022-12-01 15:34:10
Model:	RFL-C4000S
Laser SN:	0
Main control SN:	370049000550325636303020
Key:	197
System info:	PCB:50003585 Author:Raycus Version:V4.2 Brief:C3000_12000S Date:Nov 8 2022 09:39:52
	Close

Figure 11 "About" menu

#### 4.7.4 Select language

In the language selection menu, you can set the language used by the software. After selecting the language and clicking OK, the software will automatically convert the content displayed in the software to the language without restarting the software. At the same time, the currently selected language will be saved to the configuration file. When you start the software next time displays in the last language set.

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Wuhan R	CM4100	elect laser	🎒 Mode 🖪	Language	e 🥑 Licen	se 💽 About '	<del>-</del> Minimize 😫 Exi
<b>1</b> % Power[%]	0.07 kW	0 Temper	°C	Power	Rea	ndy Alar	rm Emission
Control Log Alarm Mast State Emergency	ter module ACDC module	e DCDC	module Control	ain power	OF	D R	leset
<ul> <li>Laser enable</li> <li>Fiber interlock</li> <li>Interlock logic</li> </ul>	Ten	Sele	ect	_	Ð	External con	itrol ONO
Interlock1	Langi Analo F	uage Eng	lish Cancel	~	Fall t	ime[ms]	Read Set
Ramp control Program mode	Pulse width 0.000	[ms]	External Er			External Emi	ssion ON
Program execut     Program complete     Program exception	Fiber water flow 0.000 Laser water flow 0.000 Fiber temperature 0	[L/min] [L/min] [°C]	Power[%]     Power[W]			QCW Mo	
Laser use time Today power on time 00:15:40	Total power on time 0	1:28:03	Frequency 100	Duty 100.00	PulseWidt	h	<b>W</b> 4000W
Laser IP: 192.168.0.10	State: Conne	cted	Read	Set 🗆 S	ave param	eter Versie	on: V1.21

Figure 12 Select language menu

#### 4.7.5 Authorization

The authorization menuis used to control the time-limited lock of the laser. When the authorization menuis opened, the machine code, laser lock time and lock time are loaded once. The laser lock time is Raycus ' time-limited lock for integrators, and the lock time is for integrators to end customers. time-limited lock. On the authorization menu, only the authorization code of Raycus can be set, and the function of calculating the authorization code is implemented in the server, which has nothing to do with the Raycus software. The authorization code used by the integrator can be generated in the authorization menu.

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#### RFL-C2000S-HP /RFL-C3000S-HP /RFL-C4000S-HP/RFL-C6000S-HP

Wuhan Raycus Fiber L LCM4100	aser 😰 Select laser 🏶 Mode	🖬 Language	🖉 License 🛙	About 🔻 Mi	nimize 🙁 Exit
1 % 0.07	License		0		
Power[%] Power	Set lock date		Ready	Alarm	Emission
Control Log Alarm Master module	Laser license code:	Set	Pro-		
State	License code:	Set			
Semergency	License infomation		OFF	Rese	t
Laser enable Ten	Laser SN: 0				
Fiber interlock	Laser lock date: Unlimited		<b>FF</b> Exte	rnal control	ONO
lnterlock logic	Lock date: Unlimited				
Interlock1 Analo	Generate license code		Fall time[n	ns]	Read Set
Interlock2 F		Unlimited	1	~ OFF	Read Set
Ramp control		Unininited	C Exto	rnal Emission	
Program mode Pu	Laser SN: 0	Modify			
Program execut Fiber v	Password:	Set	Q Q	CW Mode	OFF
Program complete Laser v	License code: -	Generate			
Program exception Fiber ten		1	-06	9	- + 4000W
Laser use time	Close		ulseWidth		
Today power on time 00:16:45 Total pow	100 1100 1100 1100	100.00	10.00		
Today laser on time 00:00:03 Total las	ser on time 00:27:54 Read	Set Sa	ave parameter		
Laser IP: 192.168.0.10 S	tate: Connected	Diagnost	tics	Version:	V1.21

Figure 13 "Authorization" menu

#### 4.7.6 Mode Selection

Mode selection is used to select the mode of the current software, including observation mode, control mode, diagnosis mode and debugging mode.

Observation mode: When the software is opened, the observation mode is selected by default. The most commonly used and concerned information is displayed on the software menu. The observation mode can be used without a password.

Control mode: The control mode adds the function of the operable control menu on the basis of the observation mode. A password is required to enter the control mode. The initial password is 81338818 (the password can be modified).

Debugging mode: On the basis of the diagnostic mode, the debugging mode adds a parameter setting menu, an encryption mode that only Raycus engineers can enter.

Diagnosis mode: When the laser fails and needs to be diagnosed remotely, or the integrator needs to know more status information of the laser, it can enter the diagnosis mode. The diagnosis mode adds the status and alarm information of the main control module, slave control module, ACDC module and DCDC module on the basis of the observation mode. A password is

required to enter the diagnosis mode. The initial password is 81338818 (the password can be modified).

#### 4.7.7 Master module

The Master module contains all the status, alarm and system parameters of the main control module, and the status and alarm information are automatically refreshed.

VRa	Wuhan R	aycus Fiber La C <b>M4100</b>	aser 👰 Sele	ect laser <mark>೫</mark> Mode	🖬 Language	e 🧭 License 💿 Ab	out 🔻 Minin	nize 🙁 Exit
	<b>1</b> % Power[%]	0.06 Power[k	kW <sup>w]</sup>	0 °C Temperature[℃]	Power	Ready	Alarm E	mission
Contro	l Log Alarm Mast	er module	ACDC module	DCDC module				
Basic	Power monitor   Tem	np monitor   \	Vater monitor	Power correctio	n Optical S	System		
State	External MOE Analog switch CPLD receive CPLD receive CPLD receive Fiber interloch Time limited I Laser registrat RTC failure Temp sensor	on enable guide laser on laser on ready c ock S tion code V failure C er high C	Primary or Secondary Secondary ACDC ON DCDC ON Factory multiple lave communicative Vater in laser1 Vater in laser2 Optical exception CPLD alarm	n External ma External ma External res External las External gu CPLD guide ode MCU main tion Power su Laser exc Surge pro Condensa Fiber inte	ain power ( set ( ser enable ( bide laser ( power on ( pply ( eption ( otect invalid ( ation alarm ( rlock (	<ul> <li>Front board start</li> <li>Front board power</li> <li>Front board ready</li> <li>Front board alarm</li> <li>Front board emission</li> <li>Temp High</li> <li>Low temperature</li> <li>High reflection</li> <li>QD timeout alert</li> <li>Dehumidity time</li> </ul>	Power hea er PCB versi y PCB ty n CPLD versi sion MCU versi Fiber interlock Dew	th 0.075 on 4.4 pe 5000358 on 4.6 on 4.2 (V) 0.019 alert
Para	Humidity detect Dehumidify enable QD monitor	OFF OFF OFF	Interlock dete Record langua Read	age OFF	Guide laser External ar Laser powe protect start vo	ratio 30 halog 1.000 er[W] 4000 ltage 0.600	Laser SN [ Dew limit [ Laser Type [ MOD filter [	0 22.000
Laser I	P: 192.168.0.10	St	ate: Connect	ed	Diagnos	stics V	/ersion:	V1.21

Figure 14 Main control module status information menu

Connect to the network through the main control module system parameter menu:

AP mode: the laser is a WiFihot-spot (hot-spot name and password can be configured), after the mobile phone is connected to the laser WiFi hot-spot, you can use the Raycus mobile APP to view the real-time status of the laser;

STA mode: The laser can automatically connect to the mobile phone hot-spot or wireless router (the hot-spot name and password can be configured), the laser establishes a connection to Raycus' cloud server through WiFi, and sends real-time data, which can realize remote viewing and parameter setting functions.

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VRay	/ <b>CUS</b> <sup>Wi</sup>	uhan Raycus Fiber <b>LCM4100</b>	Laser 👰 Selé	ect laser 🎒 Mode 🛙	a Language	🕝 License 💿	About ┯ M	inimize 😫 Exit
F	<b>1 %</b> Power[%]	0.06	kwj	0 °C Temperature[°C]	Power	Ready	Alarm	Emission
Control	Log Alarm	Master module	ACDC module	DCDC module				
Basic Pc	ower monitor	Temp monitor	Water monitor	Power correction	Optical Sy	stem		
WiFi para	AP Mode O Name Password Read	STA Mode	MQTT encrypt p Key versc K	ara	Read Set	Para configur Save commun Load fro	ration hication data ( m file Sa	<b>OFF</b> we to file
Laser IP:	192.168.0.7	10	State: Connect	ed	Diagnost	tics	Version:	V1.21

Figure 15 Main control module system parameter menu

#### 4.7.8 ACDC module

The ACDC module page contains the relevant status information of the ACDC module, and the refresh interval of the status information does not exceed 100ms.

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1 % Power[%]	D.06 kW Power[kW]			<b>O</b> Temperat	°C ( ture[°C] Power R	eady	Alarm	Emission	
trol   Log   Alarm   Master	module	ACDC n	nodule	DCDC m	odule				
	ACDC1	ACDC2	ACDC3	ACDC4		ACDC1	ACDC2	ACDC3	ACD
ACDC Input					Version	0.0	0.0	0.0	0.0
ACDC Output					AB voltage	0.0	0.0	0.0	0.0
Hardware enable					BC voltage	0.0	0.0	0.0	0.0
Input over voltage					AC voltage	0.0	0.0	0.0	0.0
Input under voltage					Output voltage	0.0	0.0	0.0	0.0
Input phase loss					Output current	0.0	0.0	0.0	0.0
Input phase unbalance					Temperature	0.0	0.0	0.0	0.0
Input frequency exception					Alarm count	0	0	0	0
Output over voltage					Туре				
Output over current									
Output under voltage									
short circuit									
Error									
Temperature exception			0						
Software enable									
Communication timeout									

Figure 16 ACDC module menu

#### **DCDC module** 4.7.9

The DCDC module page contains the relevant status information of the DCDC module, and the refresh interval of the status information does not exceed 100ms.

1 % Power[%]	<b>0.07</b>	[kW]	kW	Ten	<b>O</b> nperatu	° <b>C</b> re[°C]	Po	wer	Read	y	Alarm	Emi	ssio
ntrol Log Alarm Maste	r module	ACD	ic modu	le DC	DC mo	aule			-	-			1 -
		1	2	3	4	5	6	7	8	9	10	11	1
Hardware enable	(												
Software enable								0					(
Input over voltage	(		0	0		0			0			0	0
Input under voltage	(	0	0	0		0	0	0		0	0	0	(
Output short circuit	(			0	0	0	0	0	0	0	0	0	(
Output under current	(			0		0		0	0			0	(
Output over current	(										0		(
High temperature	(												(
Output over voltage	(												(
Communication timeout	(												(
Ready													(
Input voltage[V]	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	C
Output vlotage[V]	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Output current[A]	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(
Set vlotage[V]	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(
Temperature[°C]	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(
Type													

Figure 17 DCDC module menu

#### 4.8 Control mode selection

a) AD mode

Table 14 AD mode settings

AD mode	Laser power
	INTERFACE 24-pin 12, 14-pin analog voltage 0~10V
ON	0V0%
	10
OFF	The Raycus software sets the power percentage or the communication
ΟΓΓ	command "SDC" setting

b) External enable

Table 15 External	enable settings
-------------------	-----------------

External enable	Laser enable
ON	The Positive edge of pins 18 and 20 of INTERFACE 24 pins
OFF	The laser enable button of the Raycus software or the communication
	command "EMON/EMOFF"

c) External emit laser

Table 16 External enable settings

External emit laser Laser emission
------------------------------------

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ON	The Positive edge of pins 15 and 16 of INTERFACE 24 pins
OFF	The laser emission button or communication command of the
	Raycus software "EMON/EMOFF"

#### 4.8.1 Full external control mode control mode wiring diagram (external

### analog/external enable/external emit laser)



Figure 18 External control wiring diagram

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#### 4.8.2 Control Sequence Diagram



#### 4.9 Red guide beam control

Table	17	Red	guide	beam	external	control	mode
10010	• '	1	5	C C C C C C C C C C C C C C C C C C C	•1100111001	00110101	1110 40

Red guide beam e	external control
ON	17 pin of INTERFACE:
	Positive edge - turn on the red guide beam;
	Negative edge - turn off the red guide beam.
OFF	Host software:
	Red guide beam ON - turn on the red guide beam;
	Red guide beam OFF - turn off the red guide beam.

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Raycus Wuhan R LC	aycus Fiber Laser 👔 Se CM4100	elect laser	🎒 Mode 🖥	Langua	ge 🕜 Lice	nse 💿 Abo	ut 🔻 Mir	nimize  Ex
<b>1</b> % Power[%]	0.07 kW	0 Temper	°C	Pow	er Re	) ady A	<b>Alarm</b>	Emission
ontrol Log Alarm Progr	am   Master module   AC	DC modu	le   DCDC m	odule				
Emergency	🥚 REM mode		Control	ain powe		Ð	Reset	
Laser enable	Temperature 21.936	[°C]	Guide laser					
Fiber interlock	Humidity 23.433	[%]	Guide la	ser (	OFF	External of	ontrol (	ONO
Interlock logic	Dew 0.141	[°C]	Laser					
Interlock1	Analog voltage 0.080	[V]	Rise time[	ns]	Fall	time[ms]		Read Set
Interlock2	Frequency 0.000	[Hz]	Program	No		~	OFF	Read Set
Ramp control	Duty 0.000	[%]						Cont
Program mode	Pulse width 0.000	[ms]	External Er	able	UNO	External E	mission	CONC
Program execut	Fiber water flow 0.000	[L/min]	Analog Co	ntrol (	ONO	QCW N	Лode	OOF
Program complete	Laser water flow 0.000	[L/min]	Power[%]	0				
Program exception	Fiber temperature 0	[°C]	<ul> <li>Power[W]</li> </ul>	0				- 000V
aser use time			Frequency	Duty	DulseWig	ith		
oday power on time 00:41:44	Total power on time 01	:54:07	100	100.0	10.00			
Today laser on time 00:00:03	Total laser on time 00	:27:54	Read	Set [	Save parar	neter		
ser IP: 192.168.0.10	State: Not co	innected		Diagn	ostics	Ve	rsion:	V1.21

#### 4.10 Laser power slow rise and fall mode

Figure 20 Slow rise and fall parameter menu

In the slow rise and fall setting, if any parameter is not 0, the laser will automatically enter the rise and fall mode, and if all the rise and fall parameters are 0, the rise and fall mode will be automatically turned off.

After the slow rise and fall mode is turned on, the laser performs the ramp-up program to the target power according to the set ramp-up time after the start of laser emission, and executes the ramp-down program to power 0 according to the set ramp-down time after turning off the laser.

#### 4.11 Programming Mode (Waveform Editing)

#### 4.11.1 Programming mode enabling method

In programming mode, the laser has waveform editing, storage and recall functions.

RFL-C2000S-HP/RFL-C3000S-HP/RFL-C4000S-HP/RFL-C6000S-HP

Programming mode	The laser emission is determined by the edited waveform
	Voltage of pins 15 and 16 of INTERFACE 24 pin:
	Rising edge - start the program to start executing
	Falling edge - terminate the program running
Closed: the current program	Do not execute programming
number is 0	

Table 18 Programming mode enable method

When the current program number of the laser is not 0, the laser is running in programming mode. Please use the Raycus software provided by Raycus to edit the waveform, and select the pre-running program number. The output waveform of the laser is determined by the edited waveform. When all the laser emission conditions are satisfied, the relationship between the laser emission and the programming waveform in the programming mode is as follows:



Figure 21 The relationship between laser emission and programming waveform in programming mode

#### 4.11.2 Programming setting menu (waveform editing)

Check "Display Programming Mode" in the "Mode Selection" of the Raycus software.

Wuhan Ra	aycus Fiber Laser 👰 Se M4100	elect laser	🎇 Mode 🛅	Language	e 🏉 Licer	ıse 🕐 Aboı	ut 🔻 Mi	nimize 🙎 Exit
<b>1</b> % Power[%]	0.07 kW	0 Temper	°C	Power	Rea	ady A	larm	Emission
Control Log Alarm Maste	er module ACDC module	e DCDC	module					
Emergency		Selec	t mode	in nower		D	Rese	t
Laser enable     Fiber interlock	Tempe Hu Mode:	Diagnosis	~		OFF	External c	ontrol	ON
Interlock1	Analog v Password:				Fall	time[ms]		Read Set
Ramp control	Frec	Show prog	gram mode Mo	odify Pass		× External F	OFF	Read Set
<ul> <li>Program mode</li> <li>Program execut</li> </ul>	Pulse	[L/min]	Analog Cor	ntrol 0		QCW N	1ode	OFF
<ul> <li>Program complete</li> <li>Program exception</li> </ul>	Laser water flow 0.000 Fiber temperature 0	[L/min] [°C]	<ul> <li>Power[%]</li> <li>Power[W]</li> </ul>	0		14		- 4000W
Laser use time Today power on time 00:24:54 Today laser on time 00:00:03	Total power on time	1:37:17	Frequency 100 Read	Duty 100.00 Set	PulseWid 10.00	th		9 4000W
Laser IP: 192.168.0.10	State: Conne	cted		Diagno	stics	Vei	rsion:	V1.21

Figure 22 Check the display programming mode menu

		1 Powe	er[%]	%		0	.0 Pow	6 er[k\	<b>k</b> ` ^)	w	Tem	0 perature	° <b>C</b> [°C]	Power	Ready	Alarm	n Em	lission
on	trol	Log	Ala	rm 🛛	Prog	ram	Ma	ster r	nodu	le	ACDC mo	dule   D	CDC mod	ule				
1	2	3	4	5	6	7	8	9	10	N	o Ty	ype			Paramete	er.		
11	12	13	14	15	16	17	18	19	20	-								
21	22	23	24	25	26	27	28	29	30									
31	32	33	34	35	36	37	38	39	40	-								
41	42	43	44	45	46	47	48	49	50									
51	52	53	54	55	56	57	58	59	60									
51	62	63	64	65	66	67	68	69	70		Up	Down	Delete	Clear	Сору	Paste	Wri	ite
71	72	73	74	75	76	77	78	79	80	1	STOP			No parameter		Add	Insert	Upda
21	82	83	84	85	86	87	88	89	90	2	SPT	Tir	ne[ms]	Power	W]	Add	Insert	Upda
1	02	02		05	00	07	00	00	100	3	SPR	Speed[	W/ms]	Power	W]	Add	Insert	Upda
<u>1</u>	92	95	94	32	90	97	90	99	100	4	WAIT	Tir	ne[ms]			Add	Insert	Updat
R	ofrack	alist			No	prog	ram	sele	cted	5	GOTO		Line	Col	unt	Add	Insert	Upda
	enesi	inst		· • •			langt	h. 0	2		all have been						an an an	1

Figure 23 Programming mode menu

	<b>1</b> % Power[%]				0	.0 Pow	<b>7</b> er[k\	<b>k</b> '	w	Tempe	°C	Power	Ready	Alarm	Em	ission	
on	trol	Log	Ala	rm   I	Prog	ram	Ma	ster r	nodu	le	ACDC mod	lule DCDC mo	dule				
1	2	3	4	5	6	7	8	9	10	N	о Тур	pe		Parameter	Same and		1
11	12	13	14	15	16	17	18	19	20	1	SP	T P	Time:	12ms Power:	4000W		
21	22	23	24	25	26	27	28	29	30	6	510	JF					
31	32	33	34	35	36	37	38	39	40								
41	42	43	44	45	46	47	48	49	50								
51	52	53	54	55	56	57	58	59	60								
61	62	63	64	65	66	67	68	69	70		Up I	Down Delete	Clear	Сору	Paste	Wri	te
71	72	73	74	75	76	77	78	79	80	1	STOP		No parameter	r	Add	Insert	Update
Q1	82	82	84	90	96	97	00	80	90	2	SPT	Time[ms]	Power	(W)	Add	Insert	Updat
	02	03	04	05	00	07	00	09	30	3	SPR	Speed[W/ms]	Power	[W]	Add	Insert	Update
91	92	93	94	95	96	97	98	99	100	4	WAIT	Time[ms]			Add	Insert	Update
D	ofrori	. Bet			Pre	ograi	m nu	mbe	r:1	5	GOTO	Line	Co	unt	Add	Insert	Updat
- A	enesi	i list		Co	omm	and I	enat	h: 2	8	6	EXTROWER	Mode		~	Add	Incert	Undat

#### 4.11.3 View the number of waveform

Figure 24 View the number of waveform bars

Click the "Refresh program list" button, the software will automatically list the number of waveform that have been saved, green indicates that this item has a program, and white indicates that this item is empty.

		1		%		0	.0	7	k	w	C	) °C					(	
	1	Powe	er[%]				Pow	er[k	W]		Temp	erature[°C]	Po	wer	Ready	Alarm	Em	hission
Cont	rol	Log	Ala	rm 🛛	Prog	ram	Ma	ster i	modu	le	ACDC mod	lule DCD	C module					
1	2	3	4	5	6	7	8	9	10	N	о Тур	pe			Parameter			
11	12	13	14	15	16	17	18	19	20	1	SP	PT OP		Time	e:12ms Power	:4000W		
21	22	23	24	25	26	27	28	29	30									
31	32	33	34	35	36	37	38	39	40	-				× -				
41	42	43	44	45	46	47	48	49	50			Re	ad success					
51	52	53	54	55	56	57	58	59	60			_		_				
61	62	63	64	65	66	67	68	69	70		Up	Down	佣定		Сору	Paste	Wr	ite
71	72	73	74	75	76	77	78	79	80	1	STOP		No p	aramet	er	Add	Insert	Updat
81	82	83	84	85	86	87	88	89	90	2	SPT	Time[r	ms]	Powe	er[W]	Add	Insert	Updat
91	92	93	94	95	96	97	98	99	100	3	SPR	Speed[W/r	ms]	Powe	er[W]	Add	Insert	Updat
<u> </u>			<u> </u>							4	WAIT	Time[r	ns]			Add	Insert	Updat
Re	Refresh list Program number:						er:1	5	GOTO	Li	ine	C	ount	Add	Insert	Updat		

#### 4.11.4 View waveform content

Figure 25 View waveform content

Click the waveform number to be read with the left mouse button, and the program will automatically list the original waveform list.

		1 Powe	er[%]	%		0	.O	7 er[k\	<b>k</b> '	w	Temp	) erature	°C	Power	OReady	Alarm	) Em	ission
Con	trol	Log	Ala	rm	Prog	ram	Ma	ster r	nodu	le	ACDC mod	lule D	DC mod	fule				
1	2	3	4	5	6	7	8	9	10	N	о Тур	pe		1.30	Paramete	er		
11	12	13	14	15	16	17	18	19	20	1	SP	T		Time	:12ms Powe	er:4000W		
21	22	23	24	25	26	27	28	29	30	2	310	JF						
31	32	33	34	35	36	37	38	39	40									
41	42	43	44	45	46	47	48	49	50									
51	52	53	54	55	56	57	58	59	60									
61	62	63	64	65	66	67	68	69	70		Up	Down	Delete	Clear	Сору	Paste	Wri	ite
71	72	73	74	75	76	77	78	79	80	1	STOP			No paramete	er.	Add	Insert	Update
01	12	02	0.4	05	06	97	00	00	00	2	SPT	Tin	ne[ms]	Powe	r[W]	Add	Insert	Update
01	02	03	04	05	00	0/	00	09	90	3	SPR	Speed[	W/ms]	Powe	r[W]	Add	Insert	Update
91	92	93	94	95	96	97	98	99	100	4	WAIT	Tin	ne[ms]			Add	Insert	Update
	Program number:							mbe	r:1	5	GOTO		Line	C	ount	Add	Insert	Update
D	afrac	h liet				-				1.00					In the later of the second sec	International Association of Statements and		Constraints and

#### 4.11.5 Clear all waveform

Figure 26 Clear the waveform

Click the program number that needs to be cleared, click "Clear", and then click "Write to Laser", the software will clear the waveform stored in the current laser.

#### 4.11.6 Edit waveform

First left click on the pre-edited waveform number:

V	Ray	/CL	IS	Wul	han R L(	Raycu C <b>M4</b>	s Fib <b>100</b>	er La	ser	Ş	Select las	er 🎒 N	Aode 🖪	Languag	e 🕝 License 🌘	About 🔻	Minimi	ze 😫 Exit
		<b>1</b>	er[%]	%		0	.0 Pow	<b>7</b> er[k\	<b>k</b> ' wj	w	( Temp	) eratur	° <b>C</b> e[°C]	Power	Ready	Alarm	) Em	nission
Con	trol	Log	Ala	rm 🛛	Prog	ram	Ma	ster r	nodu	le	ACDC mod	dule   [	OCDC m	odule				
1	2	3	4	5	6	7	8	9	10	N	о Ту	pe			Paramete	er		
11	12	13	14	15	16	17	18	19	20	1	SI	PT OP		Ti	me:12ms Powe	er:4000W		
21	22	23	24	25	26	27	28	29	30	2	51	01			-			
31	32	33	34	35	36	37	38	39	40					×				
41	42	43	44	45	46	47	48	49	50				Read suc	ccess	-			
51	52	53	54	55	56	57	58	59	60				_					
61	62	63	64	65	66	67	68	69	70		Up	Down		确定	Сору	Paste	Wri	ite
71	72	73	74	75	76	77	78	79	80	1	STOP			No parar	neter	Add	Insert	Update
	02		04	05	06	07	00	20		2	SPT	Т	ime[ms]	P	ower[W]	Add	Insert	Update
	02	03	04	05	00	0/	00	09	90	3	SPR	Speed	d[W/ms]	P	ower[W]	Add	Insert	Update
91	91 92 93 94 95 96 97 98 99 1							100	4	WAIT	T	ime[ms]			Add	Insert	Update	
R	Program number:							r:1	5	GOTO		Line		Count	Add	Insert	Update	
	enes	not		Co	omm	and	lengt	:h: 2	2	6	EXTPOWER	ł	Mode			Add	Insert	Update
Laser IP: 192.168.0.10 State: Conn									ate:	Coi	nnected		1	Diagno	stics	Version	ı: V	1.21

Figure 27 Edit waveform

Select Command under Command Type, then write the command and click Add.

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k	a)	/CL	IS	Wu	ihan R L(	CM4	is Fib 100	er La	ser	Ŷ	Select lase		vlode 🛅 I	Langu	age 🄇	License	About	Minimi	ze 😫 Exi
		1 Powe	er[%]	%		0	.0	7 er[k	<b>k</b> \ w]	N	0 Tempe	ratur	° <b>C</b> e[°C]	Pov	ver	OReady	Alarn	n Em	lission
on	trol	Log	Ala	rm	Prog	ram	Ma	ster	modu	le	ACDC mode	ule   C	DCDC mo	dule					
1	2	3	4	5	6	7	8	9	10	N	о Тур	e	1			Paramet	ter		
1	12	13	14	15	16	17	18	19	20	1	SPI	T D			Time:	12ms Pow	er:4000W		
1	22	23	24	25	26	27	28	29	30	2	510	P)							
1	32	33	34	35	36	37	38	39	40										
41	42	43	44	45	46	47	48	49	50										
51	52	53	54	55	56	57	58	59	60										
61	62	63	64	65	65	67	68	69	70	1	Up D	own	Delete	(	lear	Сору	Paste	Wr	ite
71	72	72	74	75	76	77	70	70	on	1	STOP	1		No pa	ramete	r	Add	Insert	Update
	12	13		13	10	17	10	13	00	2	SPT	Т	ime[ms]		Powe	r[W]	Add	Insert	Update
8	82	85	84	85	80	8/	86	89	90	3	SPR	peed	d[W/ms]		Powe	r[W]	Add	Insert	Update
1	92	93	94	95	96	97	98	99	100	4	WAIT	Т	ime[ms]				Add	Insert	Update
Program number:1							r:1	5	GOTO	T	Line		C	ount	Add	Insert	Update		
Command length: 2						2	6	EXTPOWER	I	Mode				~ Add	Insert	Update			
se	r IP:	192	.168	3.0.1	0			St	ate:	Cor	nected			Diag	nostic	s	Version	1: V	1.21

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Figure 28 Select command

The command just now appears in the program list on the left. After editing all the commands, click "Write to Laser".

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V	<b>a</b> )	/CL	IS	Wu	han R LC	taycu C <b>M4</b>	s Fib <b>100</b>	er La	ser	Ē	Select lase	er 🎛 N	/lode 🛅	Language	🕜 License 💿	About 🔽	Minimiz	ze 🙁 Exi
		1 Powe	er[%]	%		0	.0	6 er[k\	<b>k</b> \ w]	w	C	) erature	° <b>C</b> [°C]	Power	Ready	Alarn	n Em	ission
on	trol	Log	Ala	rm 🗍	Prog	ram	Ma	ster r	modu	le	ACDC mod	lule   D	CDC mo	dule				
1	2	3	4	5	6	7	8	9	10	N	o Typ	oe			Paramete	r		
11	12	13	14	15	16	17	18	19	20	1	SP	T		Tir	ne:12ms Powe	r:4000W		
21	22	22	24	25	26	27	28	29	30	2	SIC	JP JP						
	22	23	24	25	20	27	20	2.5						~				
31	32	33	34	35	36	37	38	39	40				Write suc	ress				
1	42	43	44	45	46	47	48	49	50	-								
51	52	53	54	55	56	57	58	59	60	15				确定				
51	62	63	64	65	66	67	68	69	70	-	Up	Down	,	-	Сору	Paste	Wr	te
71	72	73	74	75	76	77	78	79	80	1	STOP			No param	eter	Add	Insert	Update
31	82	83	84	85	86	87	88	89	90	2	SPT	Ti	me[ms]	Po	wer[W]	Add	Insert	Update
21	02	02		OF		07	00	00	100	3	SPR	Speed	I[W/ms]	Po	wer[W]	Add	Insert	Update
51	92	95	94	32	90	97	90	99		4	WAIT	Ti	me[ms]			Add	Insert	Update
No program selecte							cted	5	GOTO		Line		Count	Add	Insert	Update		
	enesi	i nac		C	omm	and	lengt	th: C	)	6	EXTPOWER		Mode		Ŷ	Add	Insert	Update
ase	r IP:	192	.168	.0.1	0			Sta	ate:	Cor	nected		T.	Diagnos	tics	Versio	1: V	1.21

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Figure 29 Waveform written successfully

Click "Refresh program list" again, and the newly added waveform number will turn green, indicating that the writing is successful. Click the program number, it will show that the read is successful:

#### 4.11.7 Command interpretation

Table 19 detailed explanation of waveform command word

Con	nmand code (1 byte)	Parameter 1 (2 bytes)	Parameter 2 (4 bytes)	Description			
1	STOP	None	None	The end-of-program command, which must be the last entry for each program			
2	SPT	0-65000 (ms)	0-65000(W)	It takes time for parameter 1 to change the power to parameter 2			
3	SPR	0-65000 (W/ms)	0-65000(W)	Change the power to parameter 2 by the rate of change of the power of parameter 1			

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4	WAIT	1	Wait time	0-65000m	s(int)	
5	GOTO	0-99	line	0-10000	The number of times to jump to that row	The number of times the loop jumps to the line number
6	EXTPower	1	0-10V			

#### 4.12 Steps of close

Turn off the lasers in the following orders:

- a) Turn off the laser;
- b) Disconnect the 1/4 and 2/3 pins of the CTRL-INTERFACE;
- c) Disconnect the pins 8/9 of the CTRL-INTERFACE;
- d) Turn off the chiller;
- e) Disconnect the air switch;
- f) Close the head protection cap.

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#### **5.**Common alarms and handling measures

#### 5.1 Alarm display

Connect to the computer and turn on the Raycus software, all alarm states of the laser can be displayed on the Raycus software menu, as shown in Figure 30. The laser will alarm when the internal temperature of the laser is abnormal, the power is abnormal, the scattered light is abnormal, the power supply is abnormal, the condensation is abnormal, the flow is abnormal, etc.

VRa	ycu	Wuhan R.	aycus Fiber Laser M4100	😰 Select laser 🎇 N	Aode 🛅 Language	🕝 License 🛢	About 🐨 M	inimize 😫 Exit
	1 Power	<b>%</b>	0.07 kV	N O Temperature	°C O e[°C] Power	() Ready	) Alarm	Emission
Control	Log	Alarm   Maste	er module   ACDC n	nodule DCDC modu	ule			
No 1	2022-1	Time 1-08 10:14:50	E014	T2 Open.				
			Read		Clear			
Laser IP	: 192.	168.0.10	State: (	Connected	Diagnos	tics	Version:	V1.21

Figure 30 The main menu of the Raycus software

When the laser is running, any alarm occurs (except for the Interlock abnormality), the Raycus softwaremenu will display the alarm, and the ALARM light (yellow one) on the front panel of the laser will light, and the laser will stop emitting light and lock.

When the Interlock abnormality occurs, the "laser output Ready" signal is low, and at the same time, the software indicates the Interlock abnormality, but the laser does not lock and the ALARM light (yellow) does not light up. Immediately after Interlock is normal, the laser will output a Ready signal to a high level.

#### **5.1 Alarm Handling**

Typical laser alarm descriptions and possible solutions are as follows:

Table 20 Laser alarm description and possible solutions

Alarm type	alarm description and possible solutions
	Alarm Description:
T1/T2 Alarm	Laser low temperature/high temperature alarm, which occurs when the sensor inside detects an abnormal temperature inside the laser. A high temperature alarm is generated when the temperature of the monitoring point exceeds the set upper limit, and a low temperature alarm is generated when the set lower limit is exceeded.
(Temperature	Possible solutions:
alarm - low temperature alarm and high temperature alarm)	In the event of a high temperature alarm, please check whether the water cooling system is turned on normally, whether the water temperature setting is correct, whether the chiller is working normally, whether the water connection is abnormal, etc. When the water cooling system is working normally and the water temperature drops below 30°C, please restart the laser to try.
	In the case of low temperature alarm, please check whether the actual water temperature of the chiller is too low. In addition, too low ambient temperature may also cause a low temperature alarm when the laser start at a cold machine state. If the above situation occurs, you need to wait until the chiller water temperature rises above 10 °C, and then restart the laser to try.
	Alarm Description:
	Laser internal condensation alarm means the laser detected the current laser
	internal dew point temperature < 22 °C, there is a risk of condensation.
(Condensation	Possible solutions:
alarm)	Stop using the laser immediately. Please follow the operation requirements to induct cold and dry air from the CDA interface, drain moist air from the cabinet, or improve the working environment of the laser so that the ambient temperature is lower than the internal temperature of the laser, it is recommended to build a separate air-conditioned room for the laser.

	Alarm Description:
	Laser water flow alarm, the laser internally detected that the current water flow
	is lower than the required value, there is a safety risk.
LaserWaterflow	Possible solutions:
(Laser water flow alarm)	Stop using the laser immediately. Please follow the laser operation requirements of [Section 3.3 Cooling System Installation and Requirements], check the output model and working status of the laser water cooler, and clean the laser inlet water filtration assembly. It is recommended to clean the water cooler and inlet filter assembly and replace the cooling water regularly.
	Alarm Description:
	Scattered light alarm, when the ambient light intensity of the laser exceeds the
	set value, the scattered light alarm is generated, and the laser light output
	function is locked (not unlockable). Scattered light alarms only occur when the
ScatteredLightAla rm	laser is emitted.
1111	Possible solutions:
	Restart the laser, check the red light status indicated by the laser, read the scattered light monitoring voltage value through the "slave module" of the Raycus software, and contact Raycus.
	Alarm Description:
	Power alarm, power alarm is generated when the output power of the laser
L D	cannot reach the set value. The power alarm only occurs when the laser is
Alarm	emitted.
	Possible solutions:
	Check the red light status and contact Raycus.
	Alarm Description:
	Laser power alarm, laser power supply failure or sudden power supply restart of
	the power supply system may cause this alarm.
ACDCAlarm (Power alarm)	Possible solutions:
	Check whether the input AC voltage is normal, restart the laser to try if input AC voltage is normal, and contact Raycus if the alarm continues to occur.

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	Alarm Description:
Current Driver	The current drive board alarm, which occurs when the constant current drive
Alarm (The current driver	board inside is abnormal.
board alarm)	Possible solutions:
	Try rebooting the laser and contact Raycus if alarms continue to occur.

In addition to the above alarms, if there is any problem or alarm in the using the laser, Please contact Raycus for help.

#### 6.Warranty, Return and Maintenance

#### **6.1 General Warranty**

Raycus warrants that all Raycus fiber laser products are conformed to applicable product specifications under normal use and are free from defects inmaterials and workmanship.

The warranties start on the date of shipment from Raycus for a period of time as set forth in the applicable purchase contracts or product specifications. Raycus has the right to selectively repair or replace any product that proves to be defective in materials and workmanship selectively during the warranty period. Only products with particular defects are under warranty. Raycus reserves the right to issue a credit note for any defective products produced in normal conditions.

#### **6.2Limitations of Warranty**

The warranty does not cover the maintenance or reimbursement of our product of which the problem results from tampering, disassembling, misuse, accident, modification, unsuitable physical or operating environment, improper maintenance, damages due to excessive use or not following the instructions caused by those who are not from Raycus. The customer has the responsibility to understand and follow this instruction to use the device. Any damage caused by fault operating is not warranted. Accessories and fiber connectors are excluded from this warranty.

According to the warranty, client should write to us within 31 days after the defect is discovered. This warranty does not involve any other party, including specified buyer, end-user or customer and any parts, equipment or other products produced by other companies.



◆ WARNING: It is the customer's responsibility to understand and follow operating instructions in this User Guide and specifications prior to operation-failure to do so may void this warranty. Accessories and delivery fiber and connectors are not covered by this warranty.

#### **6.3Service and Repair**

Do not open the device. There are no user serviceable parts, equipment or assemblies for user in this product. All service and maintenance shall be performed by qualified Raycus personnel.

Please contact Raycus as soon as possible when problems under warranty about maintenance happened to the product.

All repaired or replacement products must be placed in the original packaging box provided by Raycus, otherwise Raycus will have the right not to repair any product damage caused by the package.

When you receive Raycus products, please check whether the products are intact and undamaged in time, and contact the carrier or Raycus in time if there is any problem.

#### **6.4 Scrapping Requirements**

If the fiber laser has reached the service life or has serious failure and has no repair value or meets other scrapping conditions, the recycling treatment shall meet the "Regulations on the Administration of Recycling and Treatment of Waste Electrical and Electronic Products".

We reserve the right to make changes in design or constructions of any of our products at anytime without incurring any obligation to make changes or install the same on units previously purchased.

All the items about warranty and service above provided by Raycus are for uses' reference; formal contents about warranty and service are subject to the contract.

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